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AMC PAMPHLET AMCP 385-56

SAFETY DIGEST

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U.S. ARMY MATERIEL COMMAND

November 1963

Today the Department of the Army has an enviable record in the field of accident prevention. This record was achieved because the Army placed a strong emphasis on accident prevention in concert with all of its activities. In the U. S. Army Missile Command the many and ever changing advances being made in the technological fields of missile and rocket development not only require but demand that accident prevention become an integral part of each employee's daily work efforts and practices.

The defense of our country requires a readiness posture built around an arsenal of weapons that are reliable and safe to use by troops trained to utilize each weapon system for the maximum accomplishment of its designed lethality. Accidents do not fit into any part of this picture.

Presently, defense spending has of necessity created one of our major national budget expenditures and requires greater efforts to eliminate unnecessary costs. Here again accidents do not fit into the picture. In the twinkling of an eye, an accident involving a missile system could result in the loss of a defensive weapon system, property and human lives costing the Government millions of dollars.

In attempting to eliminate the word "accident" from this Command's vocabulary, our safety program not only encompasses the personnel, operations and facilities of the Command, but also is included in the design and development of weapon systems. Safety is engineered into the system itself and safety guidance and training is provided to insure the safe usage of the weapon systems by the troops.

As we advance in the development of future weapon systems, it is imperative that we never forget that an unsafe weapon compromises the combat man's position against a potential enemy.

JOHN G. ZIERDT
Brigadier General, USA
Commanding

FOREWORD

The Safety Digest is an AMC Pamphlet prepared by the Safety Division, U. S. Army Materiel Command. Its purpose is to disseminate information which can materially influence and improve safety programs at all Command establishments.

Articles are included to supplement technical knowledge as well as practical knowledge gained through experience. They provide a basis for the further refinement of safety measures already incorporated in operating procedures and process layout. To achieve maximum effectiveness, the Safety Digest should be given widespread circulation at each AMC establishment.

Articles appearing in the Safety Digest are unclassified and are not copyrighted. They may be reproduced as desired in order to bring pertinent accident prevention information to the attention of all employees.

Unclassified material believed to be of interest or benefit to other establishments is welcomed for publication in the Safety Digest. Please send articles for review to: U. S. Army Materiel Command Field Safety Agency, Charlestown, Indiana. If possible, include pictures, charts, drawings, and illustrations that clarify and heighten interest in your presentation.

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The front cover shows a U. S. Army Mauler Fire Unit and the rear cover shows the U. S. Army Materiel Command Safety Program escutcheon.

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HEADQUARTERS
DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR PERSONNEL
WASHINGTON 25, D. C.

26 SEP 1963

Dear Frank:

The Department of the Army Awards for Safety are presented annually to Commands consonant with criteria contained in AR 385-10. These awards represent Army recognition for effectiveness in the prevention of accidents.

It gives me great pleasure to inform you that your leadership and the outstanding performance of your command have resulted in the selection of the United States Army Materiel Command to receive an Award of Honor for Safety for Fiscal Year 1963.

Outstanding accident prevention programs such as that of the United States Army Materiel Command contribute significantly to the continued progress made by the Army in the control of accidental loss.

Arrangements will be made to have a representative of this Headquarters present the award plaque, symbolic of this recognition, to you during a visit to your Headquarters.

Accident and injury rates for your command, for CONUS commands, and for the Army, world-wide, are inclosed for your information.

Sincerely,

Jim

J. L. RICHARDSON
Lieutenant General, GS
Deputy Chief of Staff
for Personnel

Inclosure

Lieutenant General F. S. Besson, Jr.
Commanding General, United States Army
Materiel Command
Washington, D.C. 20315

U.S. ARMY MATERIEL COMMAND
AWARD OF HONOR FOR SAFETY
IN RESEARCH
IN STORAGE

U. S. ARMY MATERIEL COMMAND SAFETY AWARDS FOR FY 1963

The following installations have won U. S. Army Materiel Command Safety Awards. Awards will be presented in accordance with AMC Regulation 385-5. Personnel of all AMC elements that have won these awards are congratulated for their outstanding contributions to the AMC Safety Program.

Group 1

MAJOR SUBORDINATE COMMANDS

Award of Honor

	Point Score
U. S. Army Weapons Command	87.3

Award of Merit

U. S. Army Missile Command	82.3

Commendations for Safety

U. S. Army Mobility Command
U. S. Army Munitions Command

Group 2

INSTALLATIONS AND ACTIVITIES REPORTING DIRECTLY TO HEADQUARTERS, U. S. ARMY MATERIEL COMMAND

Award of Honor

San Francisco Procurement District, U. S. Army	97.0

Awards of Merit

Philadelphia Procurement District, U. S. Army	93.5
New York Procurement District, U. S. Army	84.4
Birmingham Procurement District, U. S. Army	83.3
U. S. Army Ballistic Research Laboratories	81.0
Chicago Procurement District, U. S. Army	77.0
Cleveland Procurement District, U. S. Army	75.3

Commendations for Safety

St. Louis Procurement District

Group 3

INSTALLATIONS AND ACTIVITIES REPORTING DIRECTLY TO U. S. ARMY SUPPLY AND MAINTENANCE COMMAND

Award of Honor

	Point Score
Blue Grass Army Depot	90.5

Awards of Merit

Umatilla Army Depot	89.4
Tobyhanna Army Depot	88.2
Sierra Army Depot	86.1
Tooele Army Depot	80.6
Seneca Army Depot	78.8
Erie Army Depot	70.0
Lexington Army Depot	69.5
Red River Army Depot	66.6
New Cumberland Army Depot	58.7
Atlanta Army Depot	56.1

Commendations for Safety

Savanna Army Depot
Rio Vista Storage Area
Raritan Arsenal
Pueblo Army Depot
Benicia Arsenal
Navajo Army Depot
Utah Army Depot
U. S. Army Aeronautical Depot Maintenance Center
QM Activities, Boston
U. S. Army Maintenance Board
Camp Stanley Storage Activity
U. S. Army Area Support Office, Chicago

Group 4

INSTALLATIONS AND ACTIVITIES REPORTING DIRECTLY TO U. S. ARMY MUNITIONS COMMAND

Award of Honor

Joliet Arsenal	87.8

Awards of Merit

	Point Score
Pantex Ordnance Plant	71.4
Edgewood Arsenal	70.4
Fort Detrick	66.0
Iowa Army Ammunition Plant	63.8
Holston Army Ammunition Plant	60.8
Milan Army Ammunition Plant	60.4
Frankford Arsenal	54.0

Commendations for Safety

Longhorn Army Ammunition Plant
Lake City Army Ammunition Plant
Lone Star Army Ammunition Plant
Badger Army Ammunition Plant
Cornhusker Army Ammunition Plant
Kansas Army Ammunition Plant
Sunflower Army Ammunition Plant

Group 5

INSTALLATIONS AND ACTIVITIES REPORTING DIRECTLY TO U. S. ARMY WEAPONS COMMAND, U. S. ARMY MISSILE COMMAND AND U. S. ARMY TEST AND EVALUATION COMMAND

Award of Honor

Watervliet Arsenal	78.8

Awards of Merit

U. S. Army Airborne Electronics and Special Warfare Board	77.3
Watertown Arsenal	73.8
Charlotte Army Missile Plant	72.4
Aberdeen Proving Ground	68.7

Commendation for Safety

Missile Support Command

Group 6

INSTALLATIONS AND ACTIVITIES REPORTING DIRECTLY TO U. S. ARMY MOBILITY COMMAND AND U. S. ARMY ELECTRONICS COMMAND

Award of Honor

U. S. Army Engineer Supply Control Office	88,0

Awards of Merit

	Point Score
Michigan Army Missile Plant	84.5
U. S. Army Engineer Procurement Office	83.0
U. S. Army Electronics Materiel Support Agency	73.0
U. S. Army Aviation and Surface Materiel Command	72.5
Cleveland Army Tank Automotive Plant	70.5

Commendation for Safety

Lima Army Modification Center

NON-ARMY SAFETY AWARDS

The following installations qualified under the National Safety Council award plan and will receive National Safety Council Awards of Merit.

Benicia Arsenal for operating 1,369,616 man-hours without a disabling injury from 1 July 1962 to 30 June 1963.

Fort Worth Army Depot for operating 1,000,000 man-hours without a disabling injury from 20 February 1963 to 30 June 1963.

Sharpe Army Depot for operating 1,039,628 man-hours without a disabling injury from 29 March 1963 to 8 June 1963.

Springfield Armory for operating 1,716,881 man-hours without a disabling injury from 5 April 1963 to 16 July 1963.

Travellers Insurance Company presented a safety award to Pantex Ordnance Plant, Mason and Hanger - Silas Mason Company, Inc on 14 August 1963. Presentation was for a world safety record for handling high explosives for 7,696,029 man-hours without a disabling injury from May 1959 to April 1963.

THE U. S. ARMY MISSILE COMMAND
HOME OF ARMY MISSILES

The U. S. Army Missile Command, a major commodity command of the U. S. Army Materiel Command, directs world-wide Army missile activities from its headquarters at Redstone Arsenal, Alabama. The nation's top priority program of perfecting an effective defense against attack by intercontinental ballistic missiles is also directed from Redstone Arsenal by the Nike Zeus Project Office, a Class II activity under Headquarters, AMC. The U. S. Army Missile Support Command, a major element of the Missile Command, lends logistical support to other government organizations at Redstone Arsenal.

Another Army installation at Redstone is the U. S. Army Ordnance Guided Missile School, an element of the U. S. Continental Army Command. It is here that troops of the U. S. Army, the Army's sister services, and allied countries learn to be missilemen.

Watertown Arsenal, located at Watertown, Massachusetts, is a Class II installation under the jurisdiction of the Commanding General, U. S. Army Missile Command. It is responsible for research, design, development, procurement, production engineering, manufacture, industrial mobilization planning, maintenance engineering, publications, and appropriate depot maintenance of missile containers and directly related items. The Arsenal has long been recognized for its leadership in the metallurgy and fabrication fields.

Charlotte Army Missile Plant, Charlotte, North Carolina, is a GOCO plant under the jurisdiction of the Commanding General, USAMICOM. This plant, operated by Douglas Aircraft, fabricates parts for the Nike family of missiles.

U. S. Army missiles are the proud products of more than 12,000 U. S. Army Missile Command scientists, technicians, engineers, shopmen and other personnel. These personnel are responsible for managing, developing and supporting the Free World's most versatile missile systems. They work in partnership with defense contractors across the nation to form a true Army-industry team.

It takes money to provide up-to-date weapons for the modern Army. One of the major responsibilities of the Army missile team is to make sure that the taxpayer gets a fair return for that portion of his tax dollar allotted Army missiles. This means a billion dollar a year investment for projects at universities, private research institutions and American industry. Involved are more than 40 prime contractors, 300 first-tier subcontractors and more than 5400 subcontractors in almost every state in the union.

In the Missile Command's eight major research and development laboratories, tomorrow's missiles are today's work. The Army calls it "in-house" research. It ranges across the entire spectrum of missile technology including such activities as experimentation with new high energy rocket fuels, investigation of new means for guiding missiles and advanced work in metals, chemicals and the physical sciences. The tools of the trade include massive captive test stands where missiles are held firmly in place as their motors are tested, lightning fast computers analyzing miles of test data in their electronic brains, and ever present slide rules in the hands of the engineers and scientists. The single word "facilities" is used to describe land, buildings, improvements, and specialized equipment. The Army investment in facilities at Redstone Arsenal alone is approximately $300 million dollars.

Missile hardware covers the entire spectrum of the soldier's needs--from a shoulder-fired plane killer to the two-stage Pershing ballistic missile with a range of several hundred miles. It includes missiles like Sergeant: a quick-reacting, solid-fuel, nuclear punch for the field Army and the Nike Hercules and Hawk, which guard units overseas and American cities at home from aircraft attack. Their shapes may differ but their pedigree is the same.

Since the beginning of rocket and guided missile missions, the Army has achieved significant "first" after "first."

The U. S. Army was FIRST:

- to penetrate outer space. A composite two stage rocket fired February 24, 1949 at White Sands reached an altitude of 259 miles, a record not equalled for eight years.

- to build a guided missile to intercept and "kill" an airplane. The Nike Ajax did it at White Sands on November 27, 1951. Two years later Nike Ajax became the first operational air defense guided missile in the Free World.

- to arm troops with a mobile combat missile. The Corporal missile was deployed with the 259th Field Artillery Missile Battalion at Ft. Bliss, Texas in November 1954.

- to successfully launch an intermediate range ballistic missile, the Jupiter, from Cape Canaveral, Fla., in May 1957.

- to demonstrate a solution to the aerodynamic heating problem of ballistic missile re-entry. A Jupiter-C nose cone was recovered intact from the Atlantic in August 1957, after a flight into space.

- to place a Free World satellite in orbit around the earth. Explorer I was launched from Cape Canaveral, Florida, January 31, 1958, by a Jupiter-C, only 83 days after the Army received orders to try.

- to place a made-in-USA satellite of the sun into orbit, March 3, 1959.

- to place primates into outer space and successfully recover them, May 28, 1959.

- to knock out a rocket with a guided missile. The Hawk air defense guided missile successfully intercepted an Honest John artillery rocket at White Sands in January, 1960.

- to kill a guided ballistic missile with another missile. The Nike Hercules intercepted the Corporal on June 3, 1960, at White Sands.

- to develop a guided missile--the Redeye--that can be carried and fired by one man to knock down strafing and low altitude bombing airplanes.

- to intercept an ICBM boosted target vehicle. The Nike Zeus antimissile missile system did it on July 19, 1962.

Superior missiles and associated equipment are the end result of efficient use of allocated funds, equipment and facilities by Missile Command personnel, and supporting contractors. As a matter of course, safety is an inherent responsibility of all personnel within the Command, and is vital toward the successful accomplishment of providing safe and reliable weapon systems for the combat man.

SPECIAL EQUIPMENT FOR PROPELLANT DEVELOPMENT

Dr. James E. Johnson, Safety Director
Rohm and Haas Co., Research Division,
Redstone Arsenal

Development of new propellants, particularly those having higher impulses, has required the use of many new, highly energetic chemical compounds. These compounds are completely different from those with which experience has been gained in the past, and thermal stability and impact sensitivity are largely unknown. Although tests of the compounds can be made on a smaller scale, preliminary propellant evaluation requires motors containing at least ten grams of propellant. Mixing, casting, and curing at this scale provide valuable information concerning a variety of inter-related factors, but also introduce unknown and largely indeterminate hazards. The Redstone Arsenal Research Division of Rohm & Haas Company at Redstone Arsenal has assumed that, at this point in the development cycle, all such experimental propellant mixes are capable of detonation and steps have been taken to provide adequate personnel protection.

Mixing, casting, and curing of experimental propellants are carried out remotely behind a semicircular shield of 1/2-inch steel (fig 1). The portion at the rear of the shield is lightly confined and is designed to blow out if an explosion occurs. Hand-operated manipulators pass through the shield by means of a ball-and-socket. The portion of the manipulators within the shield can duplicate all hand and arm motions. A double Plexiglas window provides for direct viewing of operations being performed behind the shield. The shield has been tested for effectiveness against various amounts of detonating high explosives. Consequently, it has been approved for use with up to 250 grams of propellant unconfined, or 30 grams of propellant in 3/4-inch diameter steel motors.

Although the shield alone provides adequate protection from the direct effects of an explosion, the operator is equipped with a hard hat and safety glasses, for protection from objects within the building that may be shaken loose by

the explosion. He also wears ear muffs because a detonation within the shield could cause sound levels to rise to a dangerous level. The dew point within the shield can be controlled (using dry air) for those compounds that demand it.

While it is still within the shield, the motor is cured and the mandrel removed. It is then transferred to an electric-powered transporter (fig 2) similar to one developed by DuPont. The main feature of the transporter is a spherical pressure vessel fabricated from 1-inch steel and designed to safely withstand the detonation of 1-lb of high explosive.

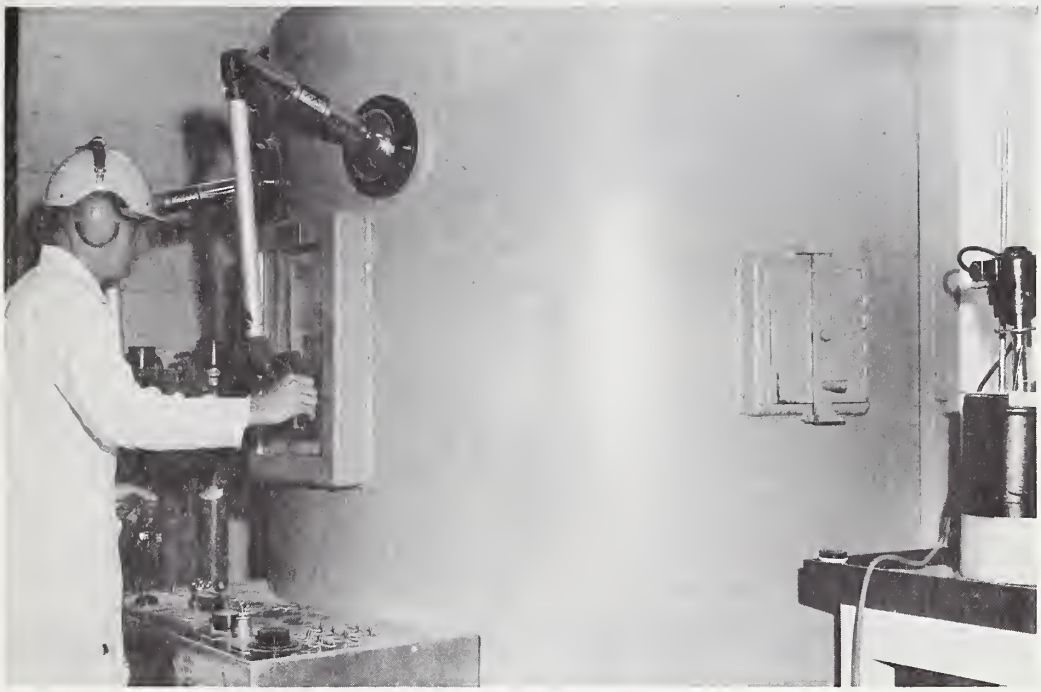
The operator is protected during the time motors are being transferred from or to the sphere by a three-sided enclosure of boiler plate. Three Plexiglas ports provide for direct viewing.

The propellant charge or loaded motor is picked up with a hand-operated manipulator which passes through the shield with a ball-and-socket, and placed in a cup which is then lowered into the sphere by a hydraulic cylinder. The circular opening within the sphere is closed by a steel plate inside the sphere.

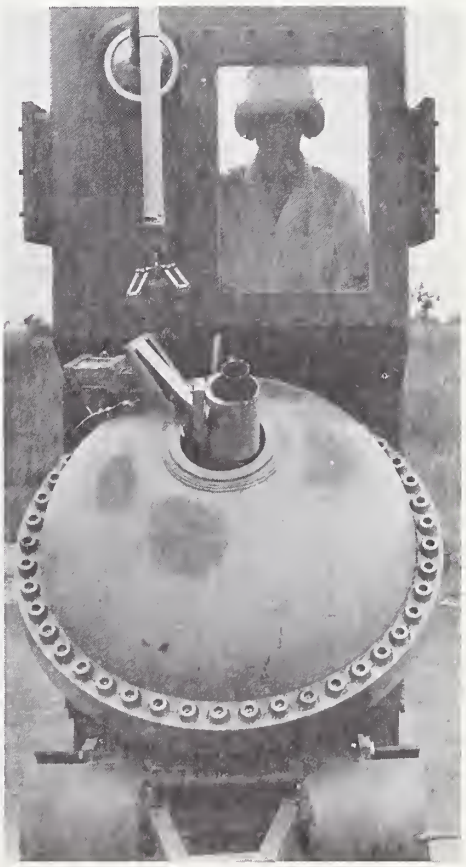
The sphere has been tested with high explosives and approved for use with up to 125 gms. of propellant confined in steel. Although the sphere is strong enough to be used with larger quantities of material, noise level has limited the amount of propellant until further tests can be made.

The operator of the transporter wears a hard hat, safety glasses, and ear muffs to reduce the probability of injuries from ricocheting pieces of metal and the flash or sound of an explosion, should one occur before the motor is safely enclosed in the sphere.

The two pieces of equipment described are examples of the extra precautions necessary to provide employee safety during research and development of new propellants.



Semicircular Operational Shield of 1/2 inch Steel



Electrically-Powered Transporter
for Experimental Propellant

HOT-ROPE HOT-STICK RESCUE DEVICE

Safety Division
U. S. Army Missile Support Command

Supervisors at the Ordnance Guided Missile School at Redstone Arsenal, Alabama made an improvement upon the method of rescuing a victim from electrical current.

At first a rope was placed at shock potential locations; later a six foot wooden stick was added. The characteristics of the rope and stick were combined into a versatile safety device. This led to the development of what is known as the "Hot-Rope Hot-Stick."

The "Hot-Rope Hot-Stick" is fabricated, using an old 3/4 inch diameter broom handle (with broom removed), and a 7 1/2' length of one-half inch rope. Clean the handle with a wire brush mounted on a bench grinder. The purpose of cleaning the handle is to remove material which might be conductive. Cut off a 10 inch segment of the handle, which will leave another piece approximately two feet, eight inches long. Drill a half-inch hole near the end of each stick. Place the rope through the holes. Each end is looped by interweaving in a standard navy pattern.

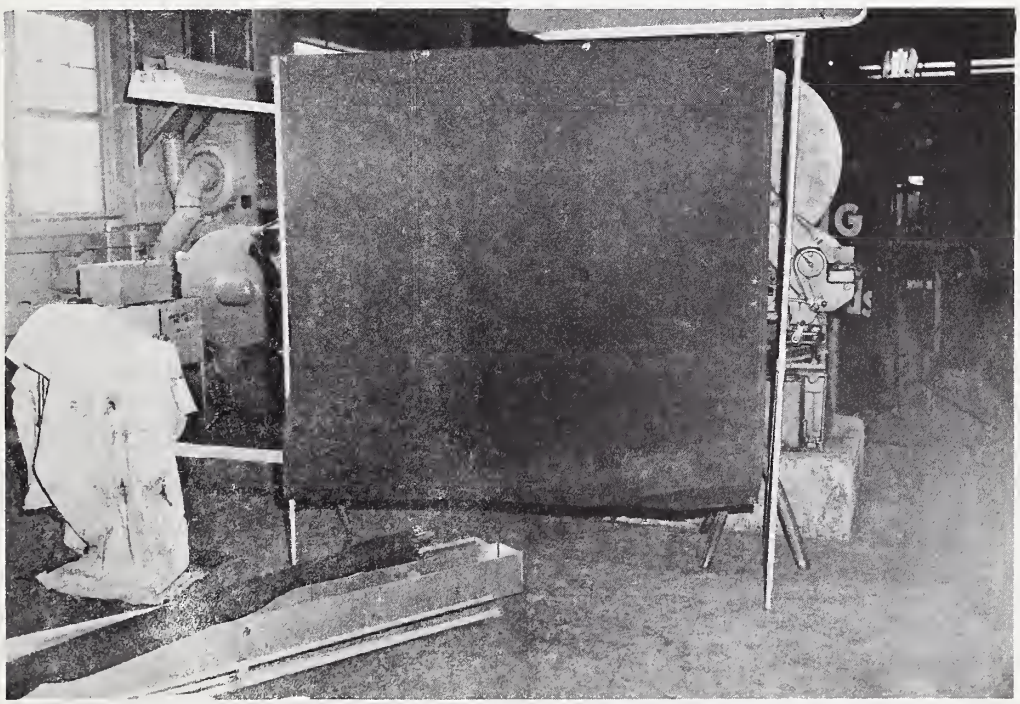
The "Hot-Rope Hot-Stick" can be used as a whip since one end is shorter than the other end. Also a person using it can hold the wooden handles while disengaging a victim from electric current. This is mounted on a board along with a mouth piece or tube which can be used in case artificial respiration is needed.

WELDERS TAKE SAFETY TO THE FIELD
Safety Division
U. S. Army Missile Support Command

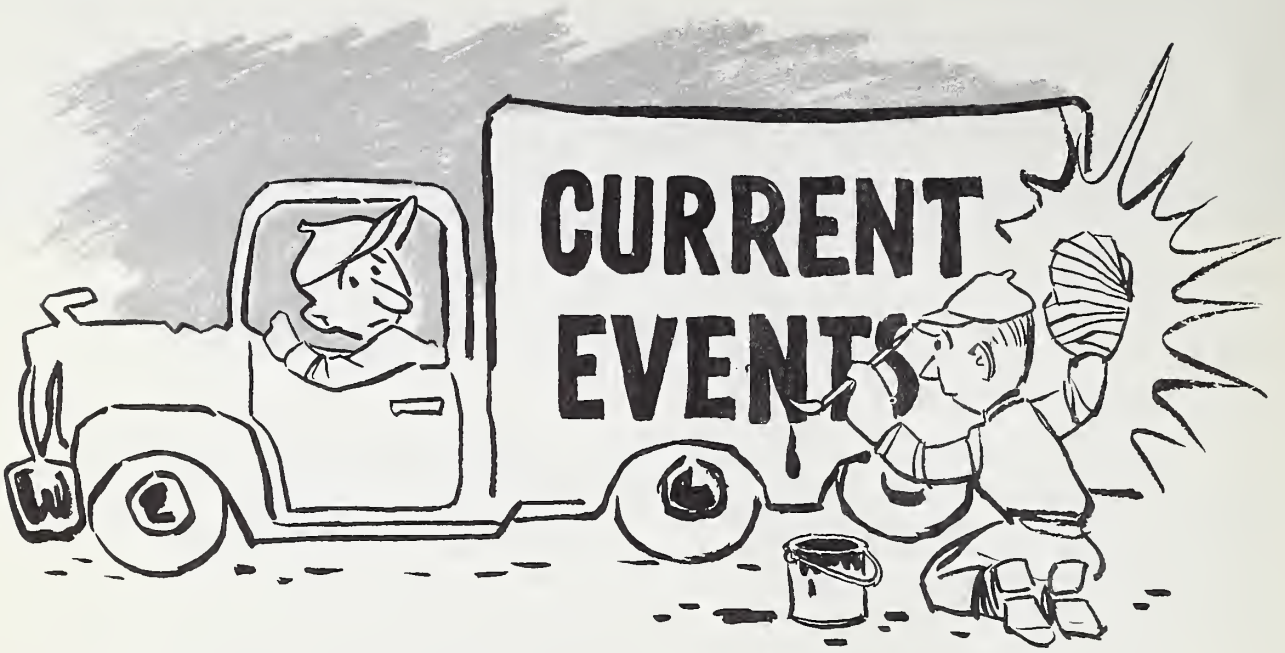
Welding in the field, or outside the shop was a safety problem for years. This was true because the welding foreman usually had no direct supervision over the assigned personnel in the given area. Employees at the Army Missile Support Command have solved this problem by developing and using portable welding screens.

The screens are constructed from frameproof canvas and three-fourths inch aluminum tube. When erected, each section is six feet high and eight feet long. A carrying case of approximately 6"x8"x9' is constructed from aluminum An asbestos blanket (to protect the work area surface) is included with each kit.

Each welding crew truck is provided with one of these kits. It is easily erected and offers ample eye protection to other employees in surrounding areas.



Section of Welding Screen, Abestos Blanket and Carrying Case



THE HANDY MAN

The driver engaged the power take off of his trash truck while the assistant closed the tail gate for compaction of the trash. After the tail gate latch had been released the gate dropped about one foot and was stopped by a piece of lumber inside the hopper. The assistant reached inside the hopper without holding the gate and removed the obstruction. Thereupon the gate fell causing severe lacerations and multiple fractures to his right hand. Fortunately, the nerves of his hand were not injured.

In order to prevent similar accidents, the following corrective actions have been taken:

1. A sign has been put on the rear of the truck - "Do not under any circumstances reach in hopper without first putting gate in locked-open position."

2. A stronger shock absorber was installed to prevent the gate from dropping rapidly.

3. Temporary employees will be oriented as to safe operation and practices, prior to working with the trash truck crew.

4. Operating procedures stress the requirement that after compactor has started a cycle, no one will reach into the hopper without first disengaging the power take off.

EXTRA!! MAN PROPELLED INTO SPACE

A contractor was awarded a contract to remove broken limbs from a tree. An employee started a cut in a limb situated approximately 50 feet above the ground. After completing 90% of the cut, assistants on the ground began pulling on a rope tied to the cut limb and succeeded in breaking the limb.

This caused another limb supporting the climber to snap up and jettison the climber several feet in the air. He then fell to the ground. The employee suffered pelvis injuries, contusions of the head and fractures of both ankles.

In the future, prior to work on similar contracts, a safety conference will be held to assure use of safe equipment and working techniques by contractor employees.

HE GOT HE GOT THE POINT

An employee placed a paring knife in his right rear pocket of his pants with the blade protruding after completion of a duty. He was then assigned to wax floors using a mop. While performing this duty, he accidentally caught his right arm on the knife causing the severe laceration of muscles of his right forearm.

This injury was the result of poor judgment. The injured man has been thoroughly informed of safe practices and methods for use and handling of sharp instruments.

All personnel on the installation have been reinstructed as to the hazards associated with their operations and were urged to exercise caution not only at work but at all times.

REPORT OF LITERATURE SEARCH OF THE TOXICOLOGICAL PROPERTIES OF PARA-QUINONE-DIOXIME

This report presents the findings of the literature search made by the U. S. Army Environmental Hygiene Agency on the toxicity of para-quinone-dioxime as requested by the R&D Directorate of the Army Missile Command at Redstone Arsenal.

The following is a list of sources and titles examined by the U. S. Army Environmental Hygiene Agency in its literature search. This list does not include the numerous texts, the Agency's correspondence, or locally available manuals which were examined also.

Sources:

Index Medicus. Jan 1953-Nov 1962.
Chemical Abstracts. Vol. 14 (1920)-Vol. 56 (Jan-June 1962).
Biological Abstracts. Dec 1945-Sep 1962
Journal of Industrial Hygiene. Vol. 1-17 (1918-1935).
Handbuch der Organischen Chemie, 4th Edition.
Advisory Center on Toxicology, National Academy of Sciences, National Research Council

Index Titles searched:

Benzoquinonedioxime
Butyl Rubber
Fuels
G-M-F
Missiles
Parabenzoquinonedioxime
Para-quinone-dioxime
Propellants
Quinones
Rockets
Rubber
Toxicology

Para-quinone-dioxime has been known for many years as a non-sulfur curing agent for natural and synthetic rubbers. Its use dates back as far as 1912, although it was not extensively utilized until the outbreak of WW II, when the use of synthetic rubber was made mandatory. Even with its long history of industrial use, very little is known of its noxious

properties. An extensive search of the available literature brought to light only one article dealing with the mammalian toxicological properties of the chemical.

Para-quinone-dioxime (G-M-F) as produced by the Naugatuck Chemical Division of the U. S. Rubber Corp., is a dark-brown powder. Its specific gravity is 1.21. Melting range starts at 215°C, at which point it begins to decompose. It is slightly soluble in acetone, insoluble in water, gasoline, benzene, and ethylene dichloride.

It might be noted here that the physical properties given for "G-M-F", in the Product Directory and Fact Book, differ somewhat from the physical properties of Quinone-dioxime given in the Handbook of Physics and Chemistry. The differences are as follows:

HANDBOOK "Quinone-dioxime"	PRODUCT DIRECTORY "G-M-F"
1. decomposes at 240°C	1. decomposes above 215°C
2. soluble in hot water	2. insoluble in water
3. yellow or colorless needles	3. dark-brown powder

It is thought that the differences noted in the two sets of properties is probably due to some slight impurities in the "G-M-F".

The acute oral LD_{50} of pure para-quinone-dioxime for mice is approximately 5 times greater than that of DDT (LD_{50} para-quinone-dioxime is 1100 mg/kg versus 180 mg/kg of DDT. However, the oral LD_{50} loses its significances in industrial application since it is not the probable route of accidental administration. Inhalation and external dermal contact are the two most common modes of industrial contamination.

Correspondence with the Advisory Center on Toxicology of the National Academy of Sciences related that when used as a converting agent for polysulfide resins, a reaction product, p-phenylenediamine, is formed. This compound is irritating, sensitizing and may produce blood dyscrasia. The chemical structure suggests that it might be irritating to the eyes, skin and mucous membranes.

No specific toxicological properties of the combustion products of para-quinone-dioxime were found. The question of combustion products of the chemical as used in a solid missile propellant is best answered by quoting Kraul and Duguid from their article, "Toxicity Problems with Solid Missile Propellants" in which they state that ".....the

chemical nature of the combustion products of solid propellants is influenced by the chemical composition of the propellant and by the conditions of combustion, for example, combustion and reaction temperature, and oxidative conditions. It is therefore difficult to obtain a complete and exact chemical analysis of the combustion products of any propellant system. However, the major constituents of the combustion products of a propellant system can be predicted with a reasonable degree of accuracy if one has sufficient data regarding the chemical composition of the propellant."

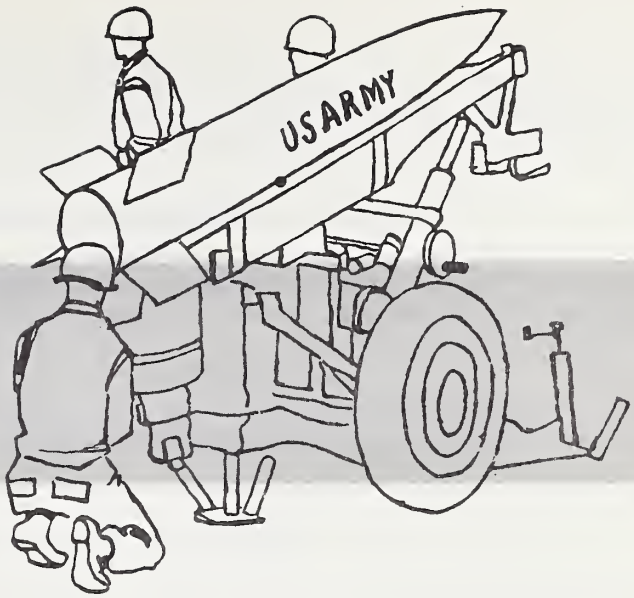
Very little is known about the toxicological properties of para-quinone-dioxime. An extensive literature search revealed only one article involving its toxicological properties. The lack of information concerning noxious effects of compounds used in the manufacture of synthetic rubber is due probably to the fact that all compounds used are considered to be hazardous and appropriate precautions are exercised in their handling.

The acute LD_{50} of para-quinone-dioxime for mice is 1100 mg/kg of body weight. Orally then, the acute oral LD_{50} of para-quinone-dioxime is approximately five times the acute oral LD_{50} of DDT. However, for industrial purposes, the oral LD_{50} loses its significance, since oral ingestion is not the usual route of accidental administration. No specific information was found on the toxicological properties of the combustion products formed by para-quinone-dioxime. When combusted as an ingredient in a rocket propellant, the combustion products are many and varied. The composition and toxicity of these products depend upon the composition of the rocket propellant as a whole.

REFERENCE PUBLICATIONS

AR 385-14 23 August 1963	Safety - Accident Reporting Procedures, Army-Shipped Non-Nuclear Explosives and Dangerous Articles Transported by Commercial Carriers
AMCR 700-17 24 Sept 1963	Logistics - AMC Product Quality Evaluation Plan (PQEP) NOTE: See paragraph 8e(2) for safety requirements.

EXPLOSIVES SAFETY



SAFETY STANDARDS FOR EXPLOSIVES OPERATIONS

John L. McDaniel Technical Director, R&D
U. S. Army Missile Command

Too often an accident involving explosives precludes a second chance. Explosives are designed for one fundamental purpose - to destroy - to destroy life and to destroy property. Therefore, it is quite essential that explosives be handled in such a manner as to insure that the explosion occurs only when and where it is desired. The explosive cannot be taught safe practices and procedures but certainly our personnel can.

There is one basic, fundamental law for explosive safety, and all other standards are amplifications, subordinations, and implementations, of this one rule. This law is: expose the minimum number of people to the minimum quantity of explosives conducive to efficient operations.

This rule is put into effect through the use of the following specific considerations:

1. With reference to facilities.

a. Operations must be properly planned and laid out.

b. Adequate and proper shielding and barricading must be provided for the protection of operating personnel and equipment.

c. Buildings and areas must be separated in accordance with quantity-distance regulations to protect personnel and property against the accidental detonation of the type and quantities of explosives involved.

2. With reference to explosives materials.

Quantities of explosives must be controlled in order to prevent unnecessary concentration.

3. With reference to personnel.

a. The number must be limited to the minimum required to efficiently accomplish the work and,

b. Personnel must be trained and required to work strictly in conformity with complete and properly approved Standing Operating Procedures.

Violations of these principles have often resulted in serious incidents at AMC installations. Crowded conditions, large and undue concentration of personnel and explosives, blocked exits, makeshift tools, and untrained employees can lead to disaster around explosives operations. All operations involving explosives materials must be carefully scrutinized and studied in order to avoid unnecessary loss of life and property on and off the installation.

It is highly important (because of today's changing conditions) that explosives operations be continually scrutinized and reviewed for the purpose of determining whether:

1. Personnel and explosives limits are consistent with safe and efficient operations; or if a reduction of personnel and/or explosives limits can be effected and still not impair the efficiency of the operation.

2. The SOP's are complete and current.

3. All personnel involved, employees and supervision, have been adequately orientated and trained, cognizant of the hazards involved in the job, aware of the reason for the safety precautions and the penalty assessed for violation.

4. Supervisors at all levels are rigidly enforcing the safety regulations firmly, fairly, and constantly.

PROPELLANT + HEAT

Jack Harbarger, Chief, Safety Engineer

Thiokol Chemical Corporation
Alpha Division - Huntsville Plant
Redstone Arsenal

For several years we have been using a movie, "Propellant + Heat," to teach our new operators and remind our older hands how to work safely with solid propellant.*

The following paragraphs are taken from the script for that movie.

The product we make at Thiokol Chemical Corporation, Alpha Division - Huntsville Plant, is solid rocket propellant. It is made to burn - suddenly, intensely, completely. It is basically a mixture of Thiokol Polymers and oxidizers.

Handled under the proper procedures, composite solid propellant can be the safest of all propellants. Under controlled procedures, polymer and oxidizer are mixed in larger mixers like dough. The mixture is poured into casting cans from which they are cast into rocket motor cases.

Solid propellants represent an achievement of numerous technological advances through years of research and development. The basic principle that makes them work is simple. They burn.

Solid propellant is made of materials that burn, so in every phase of the making of solid propellant, extreme caution must be taken to prevent accidental ignition of the chemicals or materials used.

Any time fuel, oxygen, and heat are present in sufficient proportion - fire occurs. Remove any one of these and there can be no fire.

Basically, solid propellant safety depends upon the removal of one or more of the three elements of the fire triangle, or keeping them separately.

---

*The film is available on loan from the Director of Rocket Operations Planning, Thiokol Chemical Corporation 3340 Airport Road, Ogden, Utah.

When the polymer and the oxidizers are mixed together, they have fuel and oxygen; to burn, they need only heat. Heat must be kept from the propellant.

To keep heat from propellant, the four sources of heat must be recognized. They are (1) friction, (2) impact, (3) combustion, and (4) electricity.

1. Friction heat is produced when two objects are rubbed together. This is the greatest potential source of accidental ignition of propellant. Threads rubbing together, machinery, vibration, mechanical operations generate friction heat. Good housekeeping and close check on equipment to maintain safe standards are the preventive measures to take. A positive system of accounting for small tools, to prevent them from being accidentally introduced into mixers, must be maintained. Tramp metal, which may get caught between moving mixer blades and the side walls of the mixer are friction heat sources that have caused serious propellant fires.

2. Impact heat is generated when two objects strike together. A single blow can cause propellant ignition. Ignition may occur any time a thin layer of propellant is between two hard surfaces that strike together. Surface-to-surface contact of hard objects must be avoided, or propellant must be kept from between objects that must be struck together.

3. Combustion heat results from chemical reaction. A burning cigarette is an example of combusion heat which may ignite propellant. Some chemicals are highly reactive. For this reason, a chemical handler should be sure of his chemicals. For example, certain chemicals react with water, some with other chemicals, and even with air, under certain conditions. Great respect for the chemicals and the proper techniques of handling certain materials are needed to prevent accidental ignition by combustion. Chemical containers should be marked and identified. Handlers should have thorough knowledge and respect the value of safe procedures.

4. Electricity produces heat by flow of current through a resistance or by spark discharge. An electric heater is an example of this when the coils heat up. Electric heat is controlled in solid propellant operations by automatic devices - thermostats and limitstats. Both should be set and functioning

Continued on page 25.

CLEANING PROPELLANT CASTING CANS

Jack Harbarger, Chief, Safety Engineer
Thiokol Chemical Corporation
Alpha Division-Huntsville Plant
Redstone Arsenal

The cleaning of the propellant casting cans used in the manufacture of solid propellant rocket motors has always been a hazardous operation. Recently, however, a method of minimizing this hazard has been discovered by Thiokol Chemical Corporation's Alpha Division - Huntsville Plant.

Propellant casting cans are used to transfer propellant from mixer to motor. Residual quantities of the propellant, which is a viscous material that tends to cure to a rubber-like consistency with time, will remain in the casting can. This extremely flammable material must be removed before the casting can is used again.

In the past, the removal of the propellant that adheres to the inside of the can has been accomplished by means of hand tools - spatulas, hoes, and brushes - followed by a manual washing with large quantities of water. This procedure exposes the person doing the work to a direct hazard. Should the propellant accidentally ignite while he is working, he would be either killed or seriously injured.

In the search for a safer way to clean these casting cans, various chemical solvents were tried. Although they did the job, they were very costly and very slow. Because neither the simple mechanical nor the simple chemical approaches were completely satisfactory, a combination mechanical-chemical approach appeared to be the logical solution. A method in which a hot water-detergent-caustic solution was sprayed into the can at high pressures was consequently developed. This method was very effective and very safe. The pressurized solution cleaned the case, the water reduced the possibility of accidental ignition of the propellant, and the nature of the operation permitted personnel to be away from the immediate vicinity of the casting can. Personnel are protected from the caustic acid by standard safety apparel.

Subsequently, a casting can clean-out system that could handle casting cans up to 300 gallons in capacity was designed and constructed. In this system, the casting can is positioned over a rotating nozzle. The water-detergent solution is pumped through the rotating nozzle at pressures of from 500 psi to 1,000 psi. The propellant is washed from the can and trapped and collected in a filtering basket located over an explosive-type industrial sump. The collected propellant waste is emptied daily. This technique can be used to clean casting cans in any position.

Through the use of this system, casting cans are now being cleaned quickly and effectively; but, most important of all, they are being cleaned safely.

Propellant + Heat

Continued from page 23.

properly to insure that temperature is controlled to the desired limits. Static charge is drained off by proper grounding. Personnel working in static-sensitive materials must wear conductive shoes on specially grounded floors that drain off static charge that builds up on their bodies. Lightning protection of buildings and equipment with terminals and bonded grounding keep the hazard of lightning under control. Whenever new equipment is installed or maintenance is done, the equipment should be carefully inspected to see if proper grounding is being accomplished.

As the old axiom says it - familiarity breeds contempt, but in the case of solid propellant, the more one learns of its nature the more one respects it.

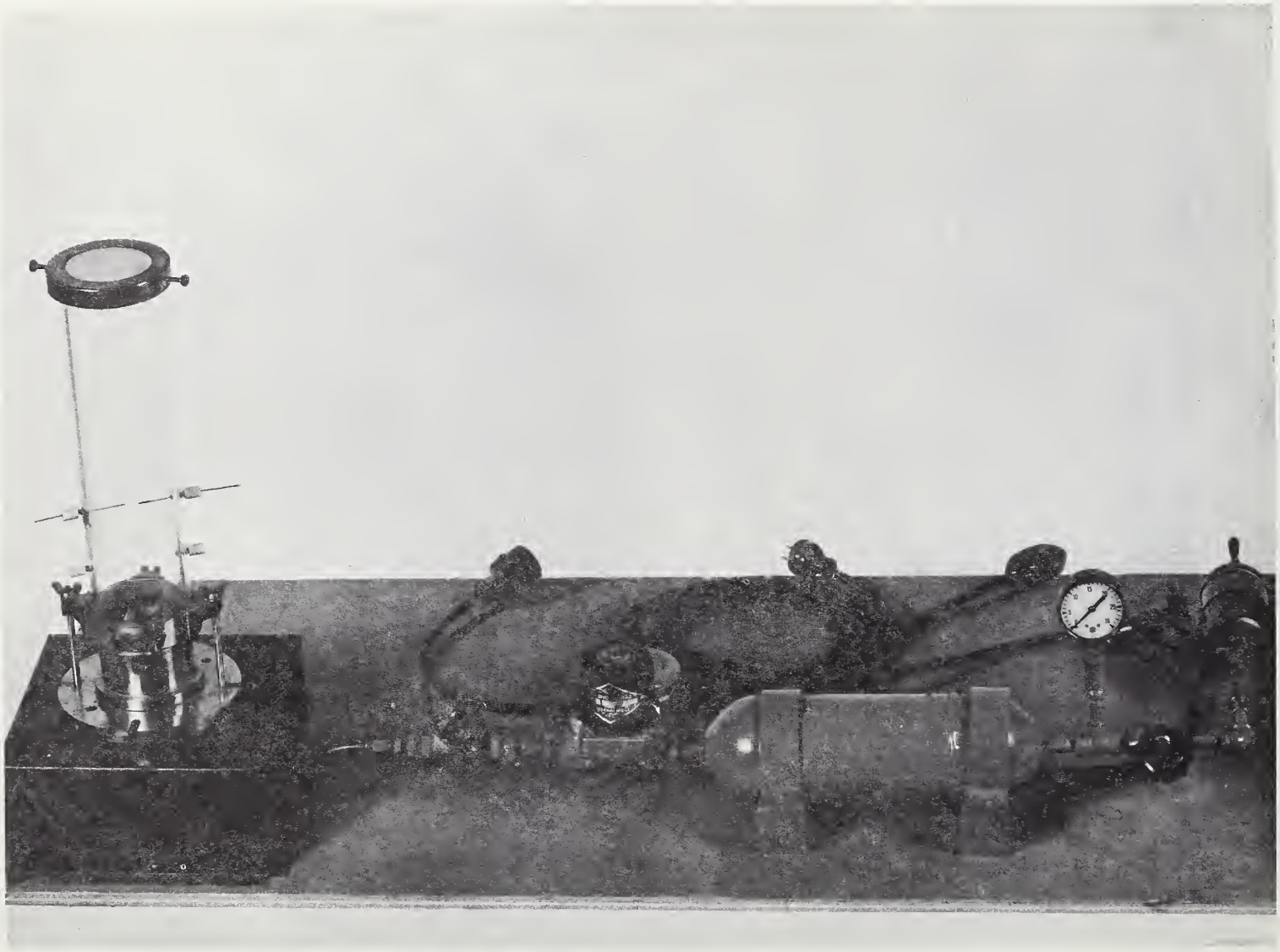
THE EXPLOSIVE CHARACTERISTICS OF DRY BIOLOGICAL AND CHEMICAL POWDERS

K. H. Hindman. Charles H. Simpson and Orley R. Bourland, Jr.
U. S. Army Biological Laboratories

The explosion potential of various dusts and powders is a well recognized hazard in many industrial operations. Until recently little was known of the extent to which biological powders (e.g.: dried microorganisms) and chemicals commonly used as nutrients for microorganisms would create explosion hazards. Tests performed for the U. S. Army Biological Laboratories of Fort Detrick by the Dust Explosion Branch of the Bureau of Mines Laboratory in Pittsburgh provided ample evidence of the potential hazards of working with these materials in a dry state.

Explosion tests were done using dried and ground preparations of a common, nonpathogenic soil bacteria with and without nutrient additives, and on dried and ground samples of dextrin, ascorbic acid, sucrose, skim milk, ammonium chloride and thiourea. All but the latter two exhibited explosive properties. For most of the test materials the minimum dust in air concentration required for explosion was as low as 0.05 to 0.08 ounces per cubic foot (50 to 80 milligrams per liter). Moreover the average rate of pressure rise at the various dust loadings tested was approximately 1,500 psi per second; the maximum rate was about 5,000 psi per second. The average ignition temperature for these materials was approximately 480° C, and the spark energy required for ignition was only about 0.08 joule or less. Further tests showed that ignition of the biological powders could be prevented by reduction of the available oxygen to a concentration of between 13 and 15 per cent by dilution of the air with nitrogen.

To facilitate the testing of other biological and chemical powders, a portable explosion test chamber on a 44 inch x 21 inch plywood base (see photo) was constructed at Fort Detrick using drawings and specifications provided by the Dust Explosion Branch, Bureau of Mines. This chamber is a valuable aid in safety training programs and demonstrations. For further details on the construction of this apparatus readers may contact Safety Division, Fort Detrick, Frederick, Maryland



Portable Explosion Test Chamber

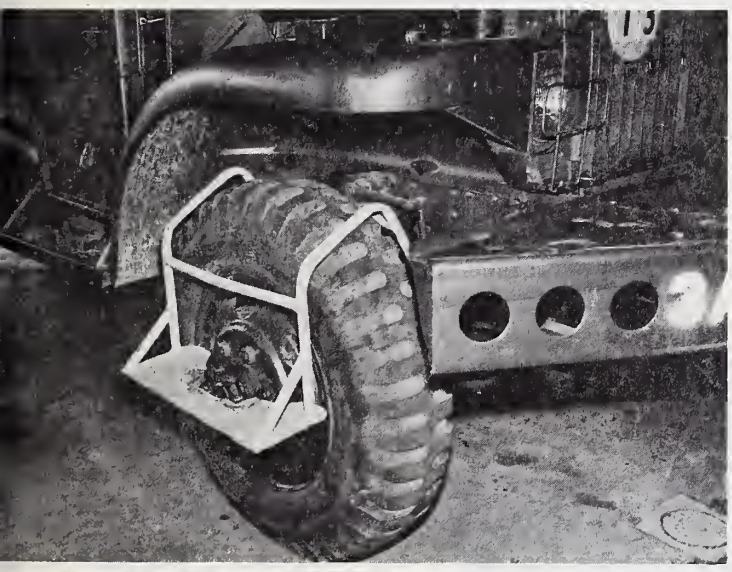
STEP UP AND STAY PUT

Safety Division

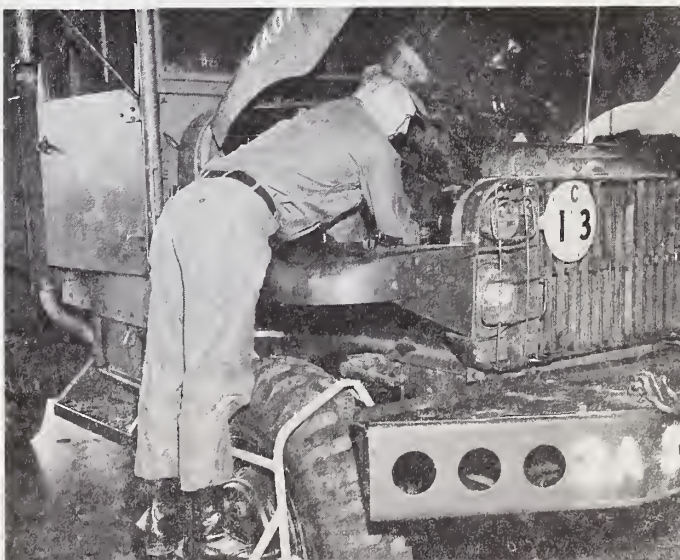
U. S. Army Missile Support Command

Automotive shop personnel in the Ordnance Guided Missile School at Redstone Arsenal were having accidents due to strains and falls while repairing trucks. This was eliminated by a "wheel step," which would support a man without slipping.

The step was fabricated from scrap material composed of three-fourths inch pipe and one-fourth inch plate; however, any size material strong enough to support a man is sufficient.



Wheel Step Fabricated from Scrap Materiel



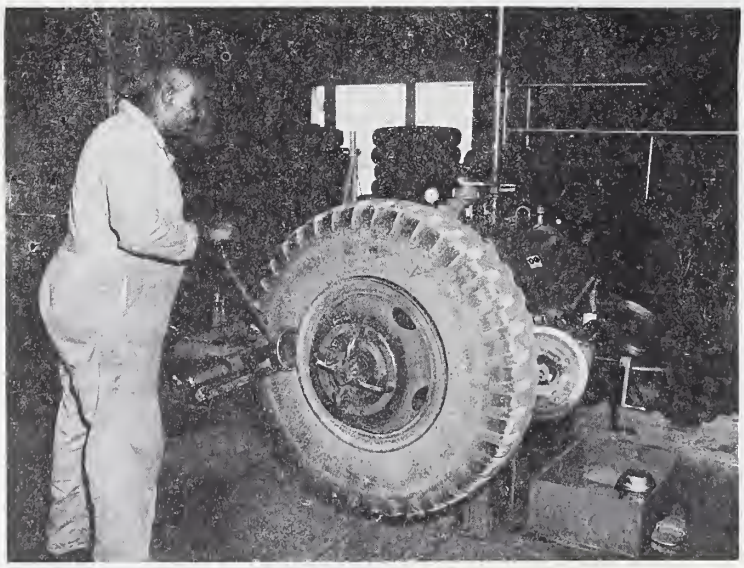
VEHICLE REPAIR SHOP
Safety Division
U. S. Army Missile Support Command

While those concerned with preventing accidents necessarily expend a great amount of effort and time to promote safe operation of vehicles, safety in the vehicle repair shop may, in some instances, be neglected.

Some of the major hazards in the vehicle repair shop are found in tire operations. Here lockrings, rims, etc., may be hurled violently and dangerously through the air because of some careless act. Also, due to handling large-size tires, back strains, hernias and hand injuries are possible. The following photos illustrate devices which, if used properly, should prevent many injuries normally associated with tire repair and mounting.

The old sledge hammer and tire tool are a source of many headaches and smashed hands. If you use only these tools to dismount tires, serious thought should be given to providing a tool such as shown in photographs 1 and 2 for removal of tires from rims.

Some means of protection should be provided while inflating tires. Improper placement of a tire on a rim, improper mounting of lockrings, or over-inflation of a tire may result in a serious injury if the employee is not protected. Such protection is provided the repairman by the metal tire cage as shown in photograph 3.

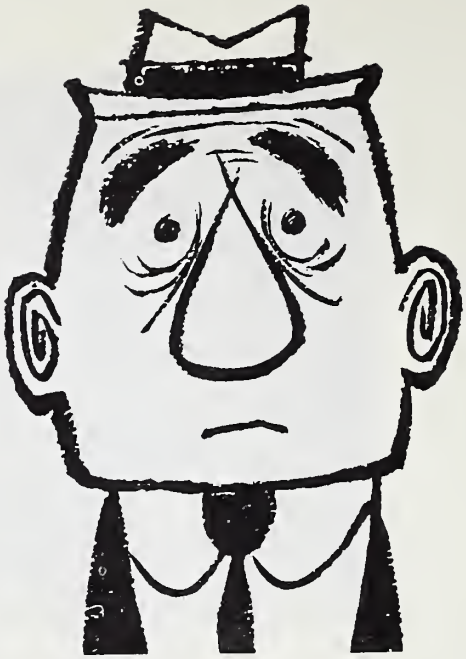


Removing a Tire from a Rim

Tire Demounting Equipment

Protection Provided While Inflating Tire

DO YOU KNOW?



AMC Circular 310-41 dated 29 August 63 redesignates the Ordnance Corps manuals in the ORDM 7 series as AMC Regulations of the 385 series. The following questions and answers have been taken from the AMC Regulations 385-224 through 385-230. Be certain to change any of the ORDM 7 series designations on your manuals to read AMC Regulation 385 as the new designation. See pages 35 and 36 for the answers to the questions shown below.

1. Is it permissible to perform electrical continuity tests for igniters assembled to composite propellant motors in the propellant manufacturing and/or motor loading line?

   Answer:

   Reference:

2. What is the minimum acceptable frequency for checking the clearances between agitator blades and composite propellant mixer bowls?

   Answer:

   Reference:

3. When is hydrostatic testing at twice the working pressure required for pressurized casting vessels for composite propellants?

   Answer:

   Reference:

4. Are fire blankets required to be fireproofed when located in igniter manufacturing areas?

   Answer:

   Reference:

5. How many presses for pyrotechnic compositions may be installed in a press loading room or cubicle?

   Answer:

   Reference:

6. Should automatic fire protection be provided for small arms ammunition bullet cutting (decoring) machines?

   Answer:

   Reference:

7. Is all electrical equipment in facilities where small arms ammunition is demilitarized required to be suitable for use in Class II hazardous locations as defined by the National Electrical Code?

   Answer:

   Reference:

8. Are multiple operations permitted in any nitroglycerin operating building?

   Answer:

   Reference:

9. What electrical safeguard must be installed on motor driven equipment used for blending and glazing of single base propellant?

   Answer:

   Reference:

10. In addition to operating controls, what safeguard against a rise in temperature must be provided for single base propellant air drying equipment?

    Answer:

    Reference:

ADD FUN TO SAFETY
Safety Division
U. S. Army Missile Support Command

Safety is a serious and demanding responsibility at all times on the part of management, supervision and all other individuals alike. However, safety promotion does not demand the continuing use of "black crepe" and "hearse backing" to be effective.

As evidenced, the 291st MP Company, Army Missile Support Command, Redstone Arsenal, has injected some real fun into their safety program activities through a game called BANGO. (See photo) This game was introduced in March of this year and the individual interest and enthusiasm, touched off by this innovation, for preventing accidents continues to be most gratifying.

The game may be played under a variety of names, but since the greatest accident concern of this organization is in traffic safety, BANGO was chosen for its connotation to vehicles banging together.

As noted in the photograph a master board is made as an ordinary Bingo card with "SAFETY IS FREE" in middle square. Bottom of board has two horizontal columns; one reads "days since last motor vehicle accident;" the other "days since last disabling injury." A square is provided at end of each column to record the number of accident free days. Face of board is provided with acetate sheet to permit repeated use. Master card is mounted on a plywood blackboard of sufficient size to accommodate strip poster safety messages at top and sides.

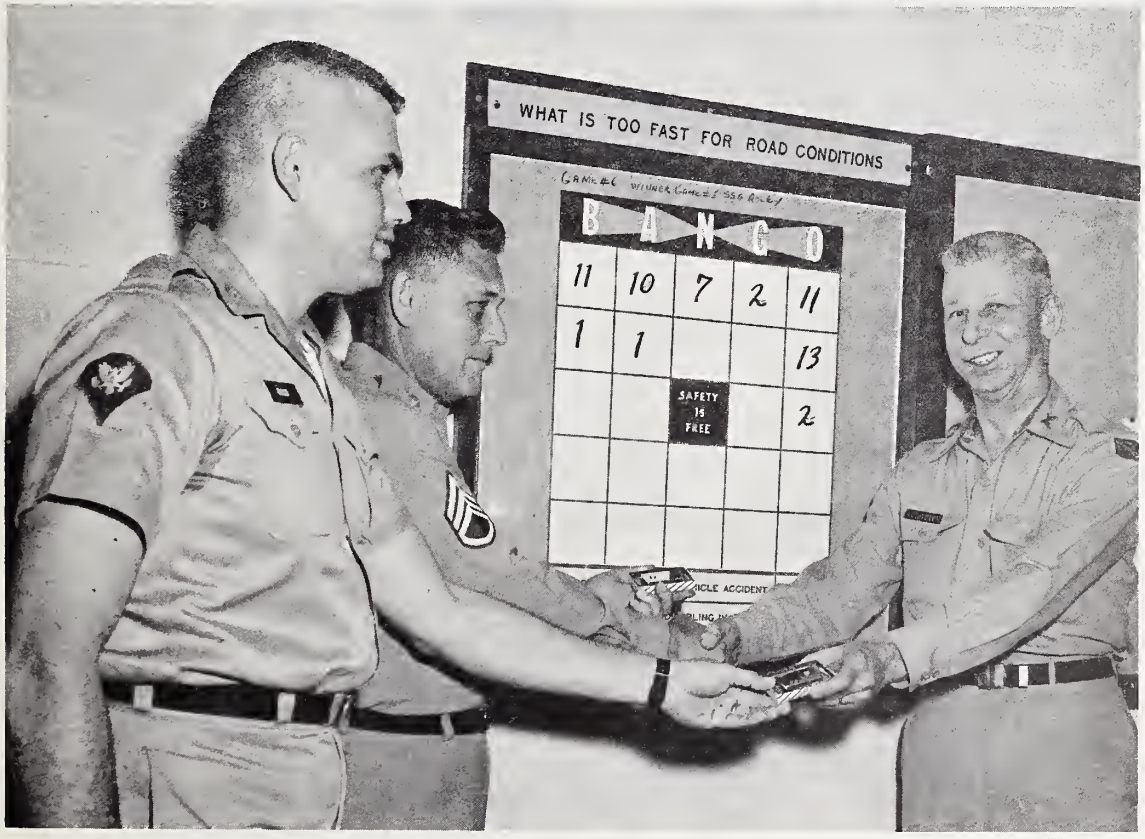
Small play cards, duplicate of master card, are produced via multilith or offset print process. Next, five series of small tabs, thirteen in each, which can be made of cardboard, are lettered according to the five letters chosen for the name of the game and numbered 0-13 for the numerical combinations to be played.

The first or last five digits of payroll number, drivers license or army serial number may be used as the basis of number combinations. Players enter their respective number horizontally in the top row of the play card, and then continue to write in the succeeding number, vertically (skip the free one) until all squares have been filled.

Master board, provided with appropriate safety information, is prominently located, and each day the game monitor draws a number from the series and starting in the top row, grease pencils in the numbers drawn in proper sequence. Players who have corresponding numbers and positions on play cards circle the number until someone gets five in a row, horizontally, vertically or diagonally. As in Bingo a new game is played following each win. Small safety incentive awards are furnished to winners. The number of wins can be regulated by frequency of numbers drawn.

Through this method, which mixes fun with accident prevention, safety messages and pertinent information is forcefully brought to the attention of all concerned, and seemingly with noted effect.

Bango was introduced into this organization 15 March 1963 following a motor vehicle accident occurring on the preceding day. As of this writing, 10 July 1963, the record remains accident-free.



WELL DID YOU KNOW?

Now that you are about to check your answers to the questions on pages 31 and 32. have you changed the ORDM 7 series to read AMCR 385 series? If you have, lets see how good your answers really are.

1. No

   Reference: Paragraph 19f(2), AMCR 385-230.

2. Not less than once daily.

   Reference: Paragraph 15d, AMCR 385-230.

3. a. At 5-year intervals

   b. After any alteration

   c. Upon report of incident or abuse

   d. When mishandled or dropped

   Reference: Paragraph 16a, AMCR 385-230.

4. Yes

   Reference 16e, AMCR 385-225.

5. One

   Reference: Paragraph 6e, AMCR 385-225.

6. Yes - Deluge type

   Reference: Paragraph 33f, AMCR 385-228.

7. No - Only locations where explosives dust conditions prevail (i.e. incendiary or tracer decoring operations)

   Reference: Paragraph 33g, AMCR 385-228.

8. Yes - In the Nitration Building

   Reference: Paragraph 15, AMCR 385-226.

9. Breaker switches that are provided with locks to prevent accidental energizing of the circuit.

   Reference: Paragraph 18f, AMCR 385-229.

10. A positive temperature stop that will override operating controls in the event of mechanical failure.

    Reference: Paragraph 17b, AMCR 385-229.

HEADQUARTERS
UNITED STATES ARMY MATERIEL COMMAND
WASHINGTON 25, D. C.

November 1963

AMC Pamphlet 385-56 is published for the information of all personnel of the U. S. Army Materiel Command.

(AMCAD-S)

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